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ABSTRACT

Bayesian data analytic procedures were used to assess the effects of a new undergraudate advising program designed to focus on students who do not initially declare a major field of study. Past research has shown that these students tend to graduate at a low rate, relative to those who do declare majors. It was hypothesized that these students also perform less well on the average than those who do declare majors. Of particular concern were high-ability, "undecided" students. Three criteria were used to evaluate the advising program: first-semester dropout rate, first-year dropout rate, and first-semester grade point average (GPA). Two samples of high-ability (ACT Composite greater than 25), undecided freshmen, coming from two entering class cohorts, were used in the study. One group was included in the new program; the other was advised in the traditional manner. The results of the study were mixed, depending on the criterion of choice. Given the selected priors and loss function, analysis with first-year dropout rate as the criterion was supportive of the program, whereas analyses with the other criteria were not. It is suggested that a similar analysis with second-semester GPA as the criterion, could further examine the effectiveness of the program for high ability, undecided students. It is also suggested that the effects of the new advising program are not fully seen until the second semester of the freshmen year. (Author/LB)

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EVALUATION OF AN UNDERGRADUATE ADVISING PROGRAM USING MULTIPLE CRITERIA

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ABSTRACT

Bayesian data analytic procedures were used to assess the effects of a new undergraduate advising program, designed to focus on students who do not initially declare a major field of study. Past research has shown that these students tend to graduate at a low rate, relative to those who do declare majors. Additionally, it was hypothesized that these students perform less well on the average than those who do declare majors. Of particular concern were high-ability, "undecided" students. Presumably, they were performing less well, and perhaps dropping out, for reasons other than inability to do college-level work. This study was planned to partially evaluate the program using three criteria: first-semester dropout rate, first-year dropout rate, and first-semester GPA. Two samples of high-ability (ACT Composite > 25), undecided freshmen, coming from two entering class cohorts, were used in the study. One group was included in the new program; the other was advised in the traditional manner. The results of the study were mixed, depending on the criterion of choice. Given the selected priors and loss function, analysis with first-year dropout rate as the criterion was supportive of the program, whereas analyses with the other criteria were not.

INTRODUCTION

An alternative to traditional student retention research is to examine the impact of specific institutional interventions. A special advising program, developed at The University of Iowa, is such an intervention.

Previous research done at the University indicated that students who did not declare a curriculum major, when they first enrolled, graduated at a lower rate than those who did (King & Geiger, 1979; King & Gressard, 1979). These "undecided" students, however, were not shown to differ from their peers in ability, as measured by ACT scores (King & Geiger, 1979). This research led to the assumption that many capable students were dropping out of college due to unfocused academic plans. Consequently, the University developed the special advising program for students who are undecided about their major field of study (Wilbers, 1979).

The special undergraduate advising program relies on the efforts of a staff of specially-trained, academic advisors. These advisors are familiar with University policies, regulations, and academic requirements. They are also familiar with the use and interpretation of students' background information, such as academic achievement, test scores and interest inventory results.

Through 1978, University practice was to, more or less, randomly assign undecided freshmen to faculty advisors in various departments. Although these faculty members were generally available to the students, it was the students' responsibility to make the contacts.

On the other hand, with the beginning of the undergraduate advising program in 1979, undecided students were assigned to the specially-trained, academic advisors. The special advisors were able to initiate frequent contacts with their advisees and, in essence, give them more attention than undecided students received in the past. An untested assumption of the new program was that the frequent, "quality" contacts with academically able, undecided students would help crystallize their academic plans and keep them from dropping out. Additionally, it was hypothesized that these students would show improved classroom performance.

The purpose of this study was to assess the effectiveness of the undergraduate advising program for high-ability freshmen with undeclared majors. Undeclared students of high ability were singled out because, presumably, they were performing less well and perhaps dropping out for reasons other than inability to do college-level work. Three distinct, quantitative criteria were used to partially evaluate the effects of the program for this group of students: first-semester dropout rate, first-year dropout rate, and

first-semester grade point average (GPA). First-semester dropout rate was defined as the ratio of students not enrolling for their second term to the total number of students in the entering class. First-year dropout rate referred to the ratio of students not enrolling for the start of their second year to the total number of students in the cohort. First-semester GPA was simply the GPA maintained by the cohort at the end of the first semester.

PROCEDURES

Samples

Two samples of students were available. They were, respectively, all undecided freshmen in the Fall 1978 and Fall 1979 entering classes. The Fall 1978 group served as the untreated sample (those not included in the special advising program) and the Fall 1979 group served as the treated sample (those included in the program). Since I was particularly interested in the effects of the program for high-ability, undecided students, only those with ACT Composite scores greater than 25 were included in each sample. This represents approximately the upper 25% of the undecided students for each year. In all, 163 students were in the 1978 sample and 181 students were in the 1979 sample.

In order to conduct the following analyses, I assumed that the classes were random samples from two different, but similar populations, with the primary difference being the influence of the special advising program. In reality, however, this assumption is violated to some extent. Since 1974, data for all entering students suggest that first-semester and first-year dropout rates have decreased by a lit-

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[1] Based on data for 1974-1978 from The University of Iowa, Registrar's Office, Spring, 1980.

tle less than one percent a year.[1] Grade point averages have increased slightly over this same period of time.[2] Obviously, there is an assumption violation apparant in these data that will make interpretation more difficult. However, it was considered and dealt with, to the extent possible, in the Evaluation of Results section.

Method

Bayesian data analytic procedures were applied in an analysis with each of the three criteria of interest. Thus, three separate analyses were actually conducted. Bayesian techniques were used to take advantage of considerable prior knowledge about characteristics of entering class cohorts at The University of Iowa.

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[2] Based on data for the Fall semesters of 1975-1977, obtained from Summary Reports 51, 55, and 59 of The University of Iowa, Evaluation and Examination Service.

ANALYSIS I - FIRST SEMESTER DROPOUT RATE

Model

First-semester dropout rate, for both the "treated" and "untreated" groups, is assumed to be distributed binomially with parameter, π_i.

Prior Distributions

Without academic advising program.

The overall dropout rate for freshmen at The University of Iowa is about .07, prior to the start of the second semester.[3] It is also known that, prior to 1979, undecided students dropped out at a higher rate than declared majors (.10 vs. .06), and that high-ability students (ACT Comp. > 25) dropped out at a lower rate than other students (.03 vs. .08). Considering all of this information, it was believed that the first-semester dropout rate for high-ability, undecided freshmen, who have not been included in the undergraduate advising program, would be about .07. This figure reflects the overall dropout rate with roughly offsetting influences due to the undecided (.10) and high-ability (.03) characteristics of the defined population.

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[3] Ibid

Based on my confidence in these figures, a prior distribution for the true dropout rate was selected. This prior was a beta, with parameters 5 and 60, a median of .07, and a 50% highest-density-region (HDR) credibility interval of (.04,.09). Thus, it was believed that the true value of the dropout rate for undecided freshmen, not in the special program, had a 50-50 chance of falling between .04 and .09. This estimate was regarded as equivalent to 65 sample observations. See the first column of Table 1 for further characteristics of this prior.

Insert Table 1 about here

With academic advising program.

The special advising program introduces another factor into the creation of the prior distribution --- the influence of the program itself. Playing the role of an advocate for the program, I believed that the program, together with the previously discussed downward trend over time, would reduce the dropout rate of high-ability, undecided freshmen from .07 to .04.

My prior distribution for the true dropout rate of the "treated" group was $\mathcal{B}(1.5, 32.5)$ with a median of .04 and a 50% HDR of (.01,.04). This estimate was regarded as equivalent to 34 sample observations (see Table 1).

Results

Of the 163 high-ability, undecided students in the 1978 class, 11 dropped out prior to the start of their second semester. The observed dropout rate for the "untreated" group, then, was .07. Thus, the posterior distribution for this group, based on my prior expectations and the observed dropout rate, was $\mathcal{B}(16,212)$ with mean, median, and mode all equal to .07, and 50% HDR ranging from .06 to .08. Further characteristics of this posterior beta distribution are shown in the second column of Table 2.

Insert Table 2 about here

Of the 181 students in the 1979 sample, 9 were classified as dropouts, yielding a first-semester dropout rate of .05. Consequently, the posterior distribution for the treated group was $\mathcal{B}(10.5, 204.5)$. This distribution has a mean and median of .05 and 50% HDR of .04 to .05. Comparison of the posterior distributions for the two groups suggested that the probability of a true difference between dropout rates for the treated and untreated students was about .83 (Table 2). Or, in other words, the probability is .87 that the dropout rate is lower for the specially-advised group than for the traditionally-advised group.

ANALYSIS II - FIRST YEAR DROPOUT RATE

Model

First-year dropout rate, for both the "treated" and "untreated" groups, is assumed to be distributed binomially with parameter, π_i.

Prior Distributions

Without academic advising program.

The overall dropout rate for freshmen at The University of Iowa is about .20, prior to the start of their second year.* Although little was known about the specific dropout rates for high-ability or undecided students, I believed that the logic applied in Analysis I would also apply here. In other words, the relatively high dropout rate associated with undecided students and the low dropout rate for high-ability students would provide roughly offsetting influences. Thus, the first-year dropout rate for high-ability, undecided freshmen, who have not been included in the undergraduate advising program, was believed to be about the same as the rate for all students --- about .20.

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* Ibid

Based on this belief, a prior distribution was chosen for the true first-year dropout rate. This prior was beta with parameters 9 and 35, a median of .20 and a 50% HDR ranging from .15 to .23. Thus, I believed that the true value of the first-year dropout rate for high-ability, undecided students, not in the special program, had a 50-50 chance of falling between .15 and .23. This estimate carried the weight of 44 sample observations. Further characteristics of this prior are presented in the first column of Table 3.

Insert Table 3 about here

With academic advising program.

Again playing the role of an advocate for the program, I believed that the program - together with the previously discussed downward trend in dropout rate over time - would reduce the first-year dropout rate of high-ability, undecided students from .20 to .15. My prior for this "treated" group, then, was $\beta(5,27)$ with a median of .15 and a 50% HDR of (.10,.18). This estimate was regarded as equivalent to 32 sample observations (see Table 3).

Results

Twenty-six of the 163 students, included in the 1978 sample, dropped out prior to the start of their second academic year. Thus, the observed, first-year dropout rate for the untreated sample was .16. The resulting posterior distribution, then, was $\beta(35,172)$ with mean, median, and mode of .17 and 50% HDR from .15 to .18, as shown in Table 4.

Insert Table 4 about here

Of the 181 students in the 1979 sample, 21 dropped out, yielding a first-year dropout rate of .12. Consequently, the posterior distribution for the treated group was beta with parameters 26 and 187. The mean, median, and mode of this distribution are all equal to .12, and the 50% HDR extends from .10 to .13. Comparison of the posterior distributions for each group indicated that the probability of a true difference between the dropout rates for the treated and untreated students was about .91 (Table 4).

ANALYSIS III - FIRST SEMESTER GPA

Model

First-semester college GPA, for both the 'treated' and 'untreated' groups, is assumed to be distributed normally with mean, μ_i, and variance, σ_i^2.

Prior Distributions

Without academic advising program.

The mean first-semester GPA for freshmen at The University of Iowa is about 2.65.[a] It is known that undecided students do slightly less well than declared majors (2.60 vs. 2.65), and that high-ability students (ACT Composite > 25) perform better on the average than other students (2.95 vs. 2.45). Considering all of this information, it was believed that mean GPA for high-ability, undecided freshmen, who have not been included in the undergraduate advising program, would be about 2.80. This figure reflects the approximate overall GPA, modified by the influences due to the undecided (2.60) and high-ability (2.95) characteristics of the defined population.

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[a] Based on data for the Fall semesters of 1975-1977, obtained from Summary Reports 51, 55, and 59 of The University of Iowa, Evaluation and Examination Service.

The average standard deviation of first-semester GPA, over the last few years, is about 0.75.* No difference in standard deviation between undecided students and declared majors is evident. However, since the assignment of students to groups based on ACT scores has the tendency to restrict the range on ability, it is not surprising that the std. deviation of GPA for both the high- and the low-ability groups is less than 0.75. Most important for this study is that the population of students with ACT composites greater than 25 have a standard deviation (σ) of about 0.70 for first-semester GPA. Since whether students are undecided or not seems to have little bearing on σ, it is believed that σ for high-ability, undecided freshmen is also 0.70.

My prior marginal distribution on the standard deviation was fit to an inverse chi with 19 degrees of freedom and scale parameter, 3.01. This distribution has a median of 0.70 and a 50% HDR of (0.60,0.75). Thus, I believed that the true value of the standard deviation had a 50-50 chance of falling between 0.60 and 0.75. This estimate was regarded as the equivalent of 20 sample observations. See the first column in Table 5 for further characteristics of this distribution.

Insert Table 5 about here

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* Ibid

Given σ =0.70, my prior conditional distribution for the population mean is centered at 2.80, with a standard deviation of 0.15. This estimate is the equivalent of 25 observations.

Finally, my prior marginal distribution on the mean was a t-distribution with 19 degrees of freedom and scale parameter, 0.36. It has mean, median, and mode of 2.8, and a 50% HDR extending from 2.71 to 2.89. Thus it was believed that the true value of the mean GPA for high-ability, undecided freshmen, not in the special program, had a 50-50 chance of falling between 2.71 and 2.89 (see column 1, Table 6).

Insert Table 6 about here

With academic advising program.

Playing the role of an advocate for the program, I believed that the program, along with the previously discussed upward trend in GPA over time, would improve mean GPA of high-ability, undecided students from 2.80 to 3.10. This change was not believed to affect the standard deviation, so the prior marginal distribution on σ was inverse chi (χ^{-1}), with 19 degrees of freedom and scale parameter, 3.01, as described earlier (Table 5).

My prior conditional distribution for the population mean, given σ =0.70, has mean, 3.10, and standard deviation, 0.15. This estimate was regarded as the equivalent of

20 observations.

The prior marginal distribution on the mean, then, was found to be $t(19, 0.45)$. It has mean, median, and mode of 3.10, a standard deviation of 0.16, and a 50% HDR from 2.99 to 3.21 (Table 6).

Results

For the untreated (traditionally advised) group of students, the observed mean was 2.92 with standard deviation, 0.79. The posterior distribution on σ for the untreated group, then, was $\chi^{-1}(178, 10.38)$ with median, 0.78, and 50% HDR ranging from 0.75 to 0.80 (Table 5). By posterior, marginal distribution on μ was t with 178 degrees of freedom and scale parameter, 0.59. This distribution has a mean of 2.90 and a 50% HDR from 2.86 to 2.94 (Table 6).

The observed mean for the treated (specially advised) students was 3.02 with standard deviation of 0.61. Consequently, my posterior distribution on the standard deviation, for the treated group, was $\chi^{-1}(194, 8.63)$ with a median of 0.62, and a 50% HDR of 0.60 to 0.64 (see Table 5). The posterior, marginal distribution on μ was t with 194 degrees of freedom, parameter, 0.38, mean, 3.03, and 50% HDR extending from 3.00 to 3.06 (see Table 6).

The standardized posterior distribution for δ (where δ is the difference between the treated population and untreated population means) is a Behrens-Fisher distribution

with 194 and 178 degrees of freedom, and angle, $\phi = 37.55°$. Use of the Behrens-Fisher to compare the two posterior distributions of the means indicated that the probability of a true difference, between the treated and untreated students, was about 0.96 (Table 7). The mean value for δ is 0.13 with a 50% HDR extending from 0.07 to 0.17.

Insert Table 7 about here

DISCUSSION

Evaluation of Results

The results of all three analyses were evaluated using a threshold loss function. With this approach, the decision, regarding the success or failure of the special advising program, is made so as to minimize the expected loss (net cost to students, the University, society, etc.) due to an incorrect decision.

A 2 x 2 layout is shown in Table 8 to represent the possible outcomes for each decision. Four outcomes were possible.

1. Decide to keep the program when, in fact, the program is ineffective (false positive);
2. Decide to keep the program and the program is truly effective (correct decision);
3. Decide to discard the program when the program is truly not effective (correct decision);
4. Decide to discard the program when, in fact, the program is really effective (false negative).

A loss is associated with each of these possible outcomes. However, the loss is zero for the two cells reflecting correct decisions.

An expected loss for each decision can then be found by multiplying the assigned loss of the appropriate cells by probability of occurrence, and then summing the cell products. The "best" decision is that which minimizes expected loss.

Insert Table 8 about here

In order to proceed, the following judgements were required:

1. The loss to be assigned for a false positive (A);
2. The loss to be assigned for a false negative (B);
3. A meaningful criterion of the advising program's success (c^{B}).

In Table 9, "A", the loss assigned for keeping an ineffective program, was given a value of 5c units.[7] This value is based primarily on estimated operating costs of the program (about $200,000 annually in salaries, office space, etc.).

Insert Table 9 about here

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[7] No understanding of the specific value of these units is required. They need be evaluated only as relative to the loss units assigned for other outcomes.

"B" was given a value of 3c units, which reflects the loss due to discarding a truly effective program. The estimate of "B" was based primarily on the assumed loss to the University, society, and the students themselves, when high-ability students drop out without receiving the benefits of the program. Other factors considered in the value of "B" were:

1. the increased load for regular faculty advisors, should the special program be disbanded; and
2. the decreased liklihood of restarting the (effective) program after it has been once tried and discarded.

Although the weighting of this loss function can certainly be argued, it seemed plausible and was used for evaluating the obtained results.

Since the three criteria are expressed in different units, the value of c^*, of course, should not be expected to be the same for all three analyses. However, the same value (.03) was selected for Analyses I and II. This value reflects the minimum acceptable difference in dropout rates for the two samples. It represents the retention of 3-4 high-ability students per year, even after accounting for the effect of a possible independent decline in dropout rate from 1978 to 1979.

In Analysis III, c^* reflects the minimally acceptable difference in mean GPA, judged to be 0.15. This represents the seemingly small increase of only a fraction of a stan-

dard deviation. However, it seems quite possible that the advising program will not be beneficial to certain students who are already capable of handling some uncertainty in their academic plans. These students, then, may not be expected to contribute to an improved mean GPA, and any improvement that is noted will likely be due to the remaining students. Thus, it may be that an improvement in mean GPA of 0.15 could represent a very substantial increase for some of the students.

Tables 10, 11, and 12 present the application of the loss function to evaluation of the results from the three analyses. Following the decision rule described in Table 8, the analyses based on first-semester criteria (dropout rate and grade point average) indicated that the "best" decision was to drop the program (Tables 10 and 12, respectively). On the other hand, the analysis based on first- year dropout rate yielded support for the program (Table 11). This support is tenuous, though, since my priors were based on an advocacy position for the program. If a skeptical University administrator does not share my beliefs, even this support dissipates.

Insert Table 10 about here

Insert Table 11 about here

Insert Table 12 about here

Clearly, these outcomes are dependent upon more than just the sample data. The priors for the treated group and the loss functions involve value judgements that could have been such so that each decision would have been reversed. However, given my priors and loss function as they were, one of three analyses supported continuation of the undergraduate advising program.

Conclusions

When the mixed results of the three analyses are viewed together, the cumulative results seem to argue against the program. However, since the program is already in place and since the analysis with first-year dropout rate was supportive, further research could be helpful. Specifically, a similar analysis, with second semester GPA as the criterion, could shed further light on the effectiveness of the program for high-ability, undecided students. Perhaps the effects of the new advising program are not fully seen until the second semester of the freshman year. This kind of delayed effect could explain why the program was supported when first-year dropout rate was used as the criterion, but not when either of the first-semester criteria were used.

Certainly, the criteria considered in this study are only three of many possible criteria for evaluating the program. A complete evaluation would have to include other populations of students as well as other criteria. But to the extent that the undergraduate advising program can be viewed as successful, it represents a post-enrollment intervention by the University that can have an effect on student performance and/or retention. Future research, together with the results of this study, may indicate that there is some administrative utility in offering the program. But from another perspective, the magnitude of the effects noted in this study - like in much other retention research - appears to be quite low. Student retention remains an elusive phenomenon.

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